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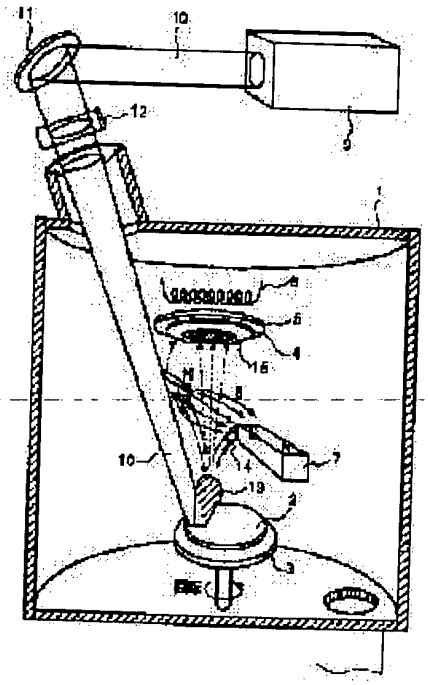
(54) PRODUCTION OF THIN FILM AND ITS DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To produce a thin film of high purity contg. no fine particles on a substrate by applying the magnetic field to the space between a target of a ferromagnetic material in which particles are generated by the irradiation of a laser beam and the substrate.

SOLUTION: In a vacuum container 1, a target 2 contg. ferromagnetic material metal elements of high purity iron or the like is arranged on a rotary mechanism 3. This target 2 is convergently irradiated with an excimer laser beam 10 from an excimer laser 9 via a reflecting mirror, 11, cylindrical convex lens 12 made of quartz or the like. In such a way, the target 2 is subjected to abrasion, and a laser plume 13 is generated to generate particles. This particles are deposited on a substrate 4 of single crystal Si (100) or the like on a substrate holder 5 to form a thin film 15 of iron or the like. At this time, the magnetic field is applied by the magnetic lines of force 8 by a permanent magnet 2 to the space between the substrate 4 and the target 2 or proximately to either of them to attract and adhere the fine particles 14 of iron. In this way, the thin film 15 of high quality contg. no fine particles can be obtd.



LEGAL STATUS

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* NOTICES *

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the thin film production method and thin film production equipment.
[0002]
[Description of the Prior Art] . by which the laser ablation method and laser ablation equipment are known as conventionally shown in the Japanese-Patent-Application-No. No. 179398 [62 to] specification as the thin film production method which used the laser beam, and thin film production equipment -- according to this laser ablation method, it is condensing and evaporating the laser beam of pulse width at a target under vacuum atmosphere, and a thin film can be produced on the substrate which countered
[0003]
[Problem(s) to be Solved by the Invention] However, when it is going to produce the thin film of a high grade by the laser ablation method, journal OBU vacuum science - and the - technology B3 (4) (1985) -- the 968th page to the 974th page (it Technolog(ies) Journal of Vacuum Science and [ ] --) As indicated by B3(4) (1985) pp.968-974, D.Lubben, S.A.Barnett, K.Suzuki, and S.Gorbatkin and J.E.Greene The thin film produced does not have uniform thickness and the thing and bird clapper in which many particles whose sizes are 0.5 micrometers - 2.5 micrometers partially were intermingled are known. For this, it is Japanese Patent Application No. 62-97372 that it is because a bumping phenomenon starts and many particles of the above-mentioned size occur by the powerful laser beam when dissolving a high grade silicon target rapidly. It is known for the number specification.
[0004] When this phenomenon happens similarly when a target contains ferromagnetic material metallic elements, such as iron, and nickel, chromium, and it is going to produce the thin film of a high grade by the laser ablation method, it is required to prevent containing in the thin film which the particle produced.
[0005]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention impresses the magnetic field for attracting a particle to the position near the target the space between the substrate which should produce a thin film, and the target containing a ferromagnetic material metallic element, or near the substrate.
[0006] Most high grade metal coats used for corrosion-resistant grant of the magnetic metal thin film used for magnetic devices, such as the magnetic head, or general industrial use parts contain ferromagnetic material metallic elements, such as iron, nickel, chromium, and cobalt. Therefore, even if it carries out ablation, a bumping phenomenon happens by the powerful laser beam and many particles generate the target containing the ferromagnetic material metallic element of these, those particles have the property which it quenches between short time to the temperature below the Curie point, and is attracted by the magnetic field. Therefore, a particle can be prevented from reaching a substrate by leading a particle to the big place of magnetic field strength by this invention by impressing the

magnetic field for attracting a particle to the position near the target the space between the substrates and targets which should produce a thin film, or near the substrate unlike the position of a substrate. Consequently, the thin film of the high grade which does not contain a particle is producible.
[0007]
[Embodiments of the Invention] The example of this invention is explained with reference to a drawing below.
[0008] Drawing 1 shows the method and equipment when using this invention, when producing a pure iron thin film on a silicon substrate.
[0009] Weight purity has arranged the high grade iron target 2 whose sizes are the diameter of 50mm, and the thickness of 2mm to the horizontal position, and made the interior of the vacuum housing 1 exhausted to ten to 5 Pa ultimate vacuum rotate it at the rate of per minute 1 rotation by the rolling mechanism 3 at 99.9999%.
[0010] Next, the single crystal Si (100) substrate 4 with a diameter of 3 inches was fixed to the interior of a vacuum housing 1 on the substrate electrode holder 5, it heated at the heater 6 in a tooth back, and substrate temperature was made into 300 degrees C.
[0011] Inside a vacuum housing 1, in the space between the high grade iron target 2 and the Si substrate 4, one pair of permanent magnets 7 are arranged in the position 10mm before the Si substrate 4 so that it may become right-angled to the shaft which connects the high grade iron target 2 and the Si substrate 4, and it is intensity 0.4. The magnetic field of a tesla was generated. The line of magnetic force 8 at that time is shown all over drawing.
[0012] It is size 50mmx0.2mm in the position where the KrF excimer laser 9 has been arranged to the exterior of a vacuum housing 1, and the excimer laser light 10 with a wavelength of 248nm which carried out outgoing radiation was converged with the cylindrical shape convex lens 12 made from a quartz, and carried out eccentricity on the high grade iron target 2 by the reflective mirror 11 after changing the direction. It irradiated, as it became. Laser-power density at this time was made into 1 - 3 J/cm2, the pulse width for 10ns, and the repeat frequency of 1-5Hz. Moreover, a target and distance between substrates were set to 50mm.
[0013] By this excimer laser light 10 irradiation, the high grade iron target 2 is heated rapidly locally, and the laser plume 13 which emitted light blue was generated. From the high grade iron target 2, although the iron particle 14 occurred, for the effect of the magnetic field by the permanent magnet 7, they were attracted in the ends side of a permanent magnet 7, and adhered.
[0014] By repeating excimer laser light irradiation and carrying out on the frequency of 2Hz for 2 hours, the iron thin film 15 of 2 micrometers of thickness was produced on the Si (100) substrate 4.
[0015] When the front face of the iron thin film 15 was observed with the scanning electron microscope, the front face was flat and it was not admitted that a particle existed. Furthermore, when the purity of the iron thin film 15 was measured by the secondary ion mass spectrometry, existence of an impurity was not accepted like the used high grade iron target 2.
[0016] In this example, although the iron thin film was produced using the iron target in vacuum atmosphere, it is also possible by introducing reactant gas, such as oxygen, and ammonia gas or hydrogen-sulfide gas, in a vacuum housing to produce metallic compounds, such as an oxide of the target metal to be used, a nitride, and a sulfide.
[0017]
[Effect of the Invention] Since a magnetic field is impressed to the position near the target the space between the substrates and targets which should produce a thin film, or near the substrate according to this invention and the particle which generates a laser beam when the target containing a ferromagnetic material metallic element is irradiated is attracted in the strong place of a magnetic field, a substrate cannot be reached. Therefore, a high grade thin film is made without including a particle in a substrate.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Explanatory drawing of this invention in the case of producing a pure iron thin film on a silicon substrate.
[Description of Notations]
1 [-- A rolling mechanism, 4 / -- A single crystal Si (100) substrate, 5 / -- A substrate electrode holder, 6 / -- A heater, 7 / -- A permanent magnet, 8 / -- Line of magnetic force, 9 / -- A KrF excimer laser, 11 / -- A reflective mirror, 12 / -- The cylindrical shape convex lens made from a quartz, 13 / -- A laser plume, 15 / -- Iron thin film.] -- A vacuum housing, 2 -- A high grade iron target, 3

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DRAWINGS

[Drawing 1]

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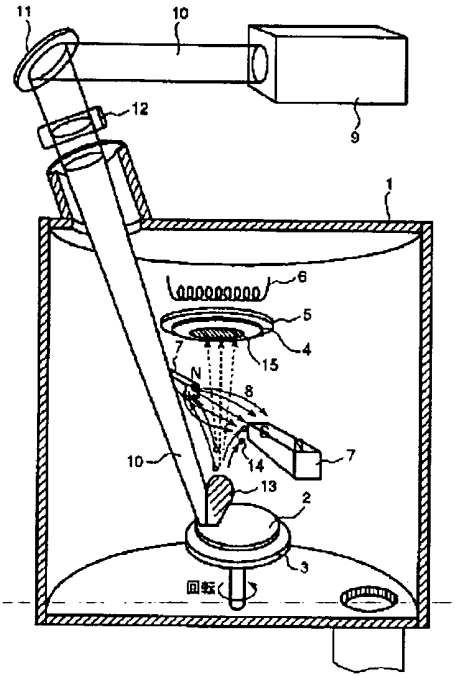

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